G. HONOLD, M. RALL & P. MUMPRECHT.

ELECTRIC IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED JUNE 13, 1911.

1,014,824.

Patented Jan. 16, 1912.

5 SHEETS—SHEET 1.

Fig. 1.

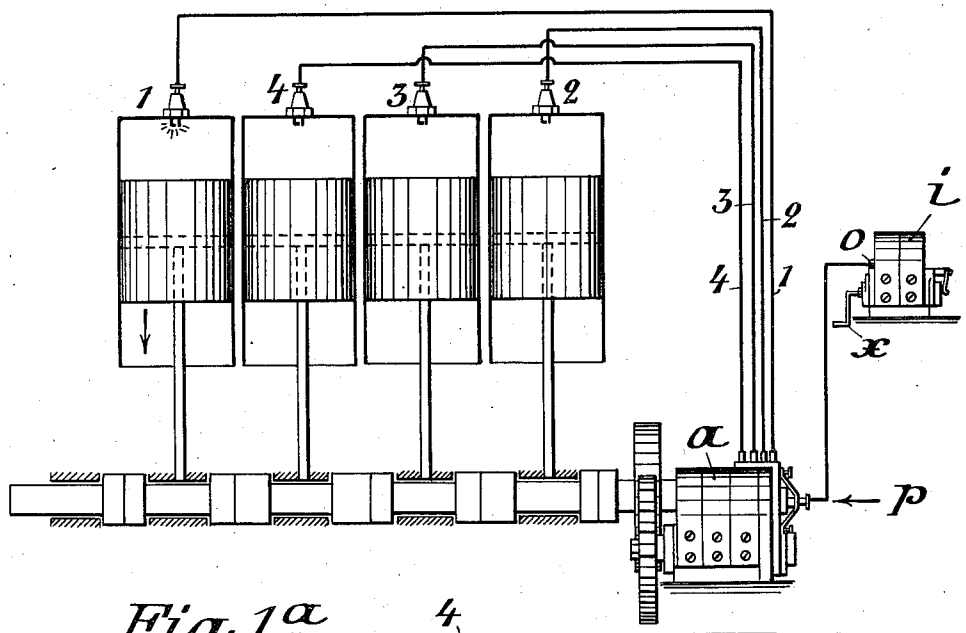
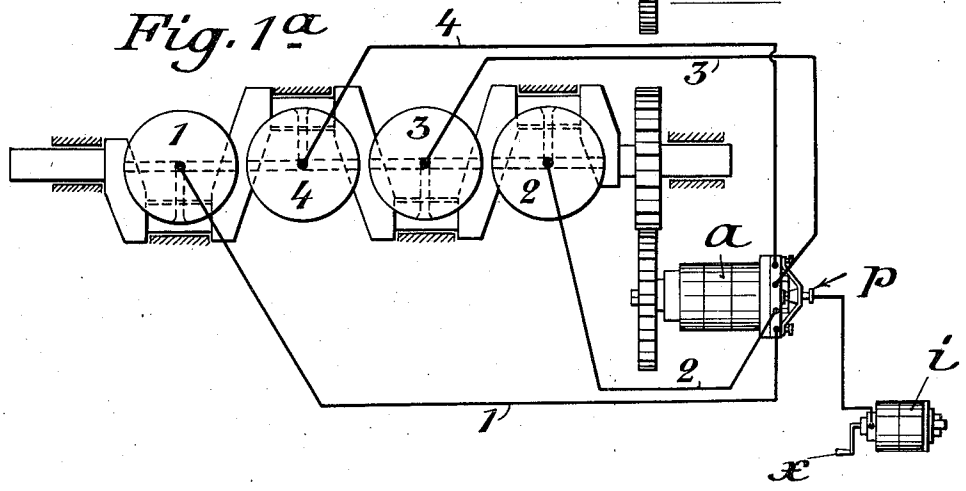


Fig. 1a



WITNESSES

F. R. Hennessy

Thos. J. Maguire

INVENTORS

Max Rall

Gottlob Honold

Paul Mumprecht

By Pennie, Davis & Goldsborough

Atty's.

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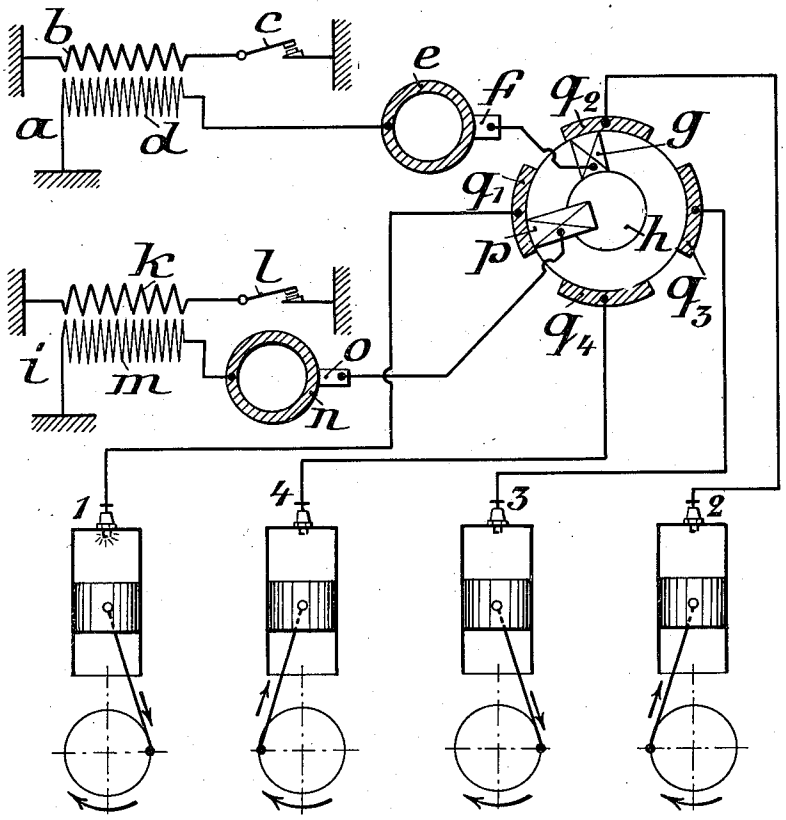
Fig. 2.



WITNESSES

C. A. Hennessy

Thos. J. Maguire

INVENTORS

Max Rall

Gottlob Honold

Paul Mumprecht

By Pennie, Davis & Goldsborough

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5 SHEETS—SHEET 3.

Fig. 3.

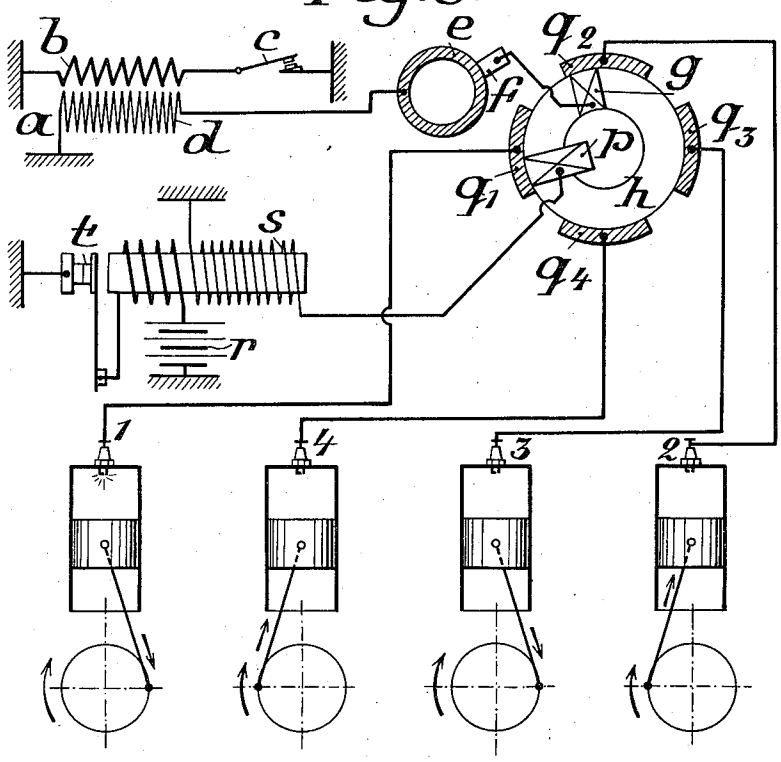
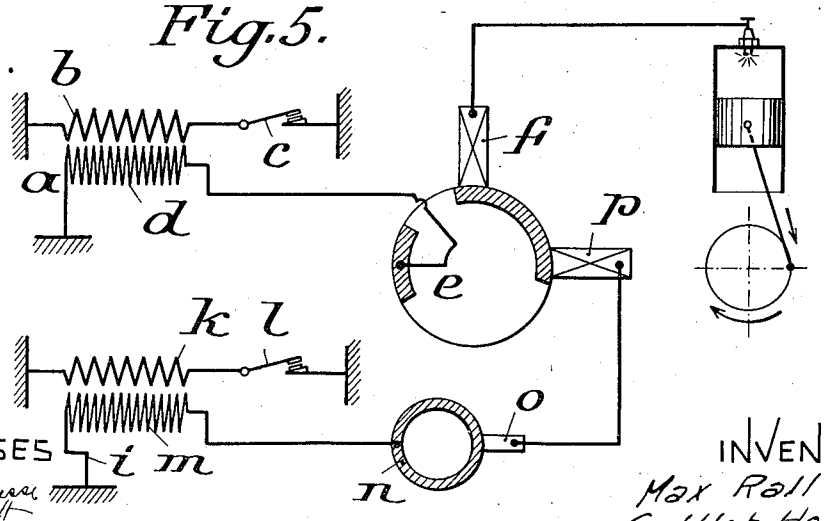


Fig. 5.



WITNESSES

U. T. Hemmer

Thos. J. Maguire

INVENTORS

Max Rall

Gotthob Honold

Paul Mumprecht

By Pennie, Davis & Goldsborough

Attys

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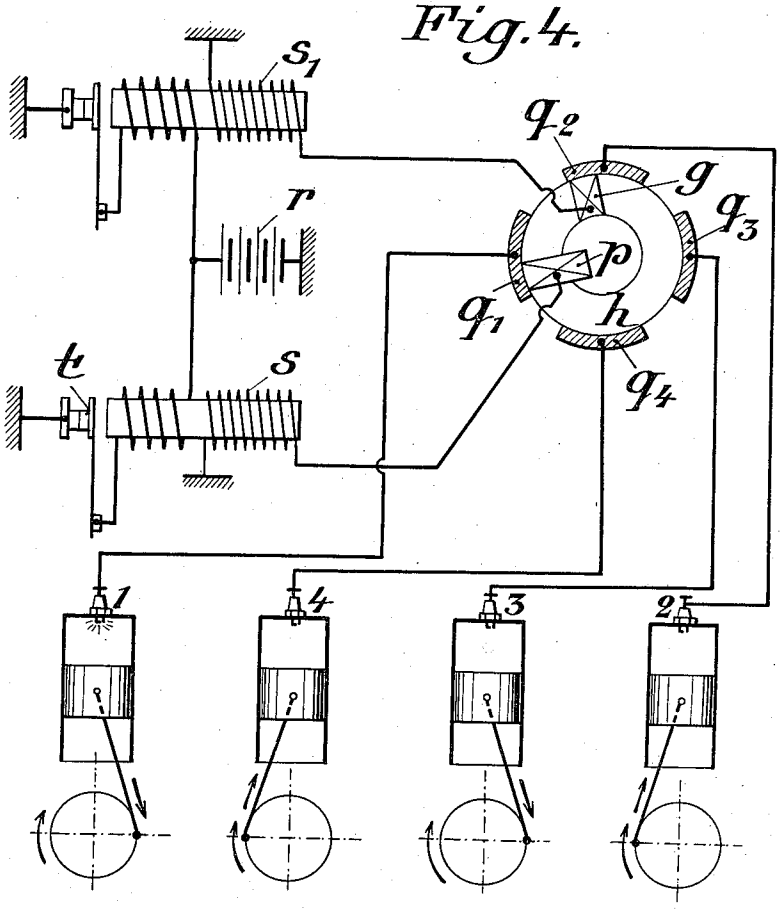
Fig. 4.



WITNESSES

C. F. A. Hennessy

Thos. J. Maguire

INVENTORS

Max Rall

Gottlob Honold

Paul Humprecht

By Penne, Davis & Goldsborough

Attys.

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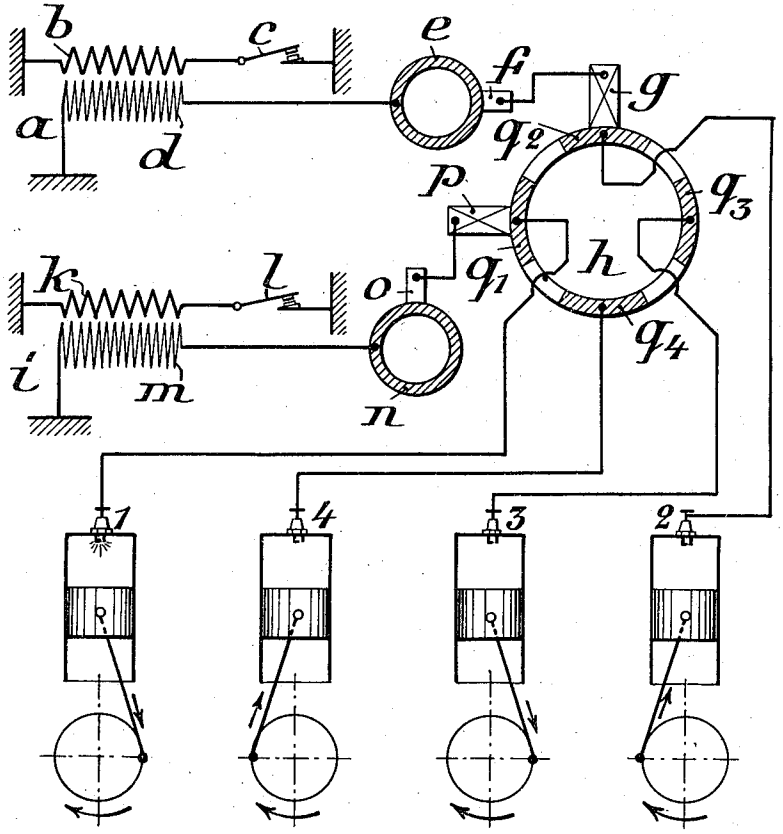
5 SHEETS—SHEET 5.

Fig. 6.



WITNESSES

Chas. A. Hennessy

Thos. J. Maguire

INVENTORS

Max Rall,

Gottlob Honold

Paul Mumprecht

By Pennie, Davis & Goldsborough

Attys.

UNITED STATES PATENT OFFICE.

GOTTLOB HONOLD, OF STUTTGART, GERMANY, MAX RALL, OF PARIS, FRANCE, AND PAUL MUMPRECHT, OF BRUSSELS, BELGIUM, ASSIGNORS TO THE FIRM OF ROBERT BOSCH, OF STUTTGART, GERMANY.

ELECTRIC IGNITION SYSTEM FOR INTERNAL-COMBUSTION ENGINES.

1,014,824. Specification of Letters Patent. Patented Jan. 16, 1912.

Application filed June 13, 1911. Serial No. 632,948.

To all whom it may concern:

Be it known that we, GOTTLOB HONOLD, engineer, a subject of the German Emperor, residing at Nos. 11–13 Hoppenlaustrasse, Stuttgart, Germany, MAX RALL, engineer, a subject of the German Emperor, residing at No. 17 Rue Theophile Gautier, Paris, France, and PAUL MUMPRECHT, engineer, a citizen of the Swiss Republic, residing at No. 121 Rue de l'Instruction, Brussels, Belgium, have invented certain new and useful Improvements in Electric Ignition Systems for Internal-Combustion Engines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to electric ignition systems for internal combustion engines, and particularly to a system having one current supply for ignition for starting and a second current supply independent of the first for ignition during running.

In systems heretofore used in which a magneto-electric machine was employed for the purpose of igniting the combustible mixtures in combustion engines difficulties have arisen in starting the engine by hand or in starting from rest by ignition. These difficulties are due to the fact that only above a certain speed of rotation does a magneto electric machine generate a voltage of the value required to produce sparks which are capable of effecting satisfactory ignition, so that ignition depends upon how quickly the crank of the motor is rotated, and to the fact that ignition cannot be satisfactorily effected by means of such a machine when the engine is at rest since the magneto should be positively connected with the engine to be driven therefrom during running.

Better results have been secured for starting and running ignition by the combination of a magneto electric machine for ignition during running with a battery for ignition during starting. However, this combination has the disadvantage that after starting by cranking, either the battery must be cut out and the magneto introduced, or two sets of spark plugs must be provided in the cylinders. When a battery alone is used for ignition, the requirements for starting are easily met, but it becomes necessary to extend the adjustment of the period of ignition over a comparatively large angle in order that the ignition may be sufficiently retarded during starting and sufficiently advanced during running. In passing from starting to running an adjustment of the period of ignition is therefore unavoidable. And furthermore even though the battery has a certain advantage for ignition during starting, it is seldom used at present for ignition during running owing to its features of unreliability for this purpose.

It has been found that when the ignition for a four-cylinder automobile engine, for example, is cut off, the engine continues to rotate until the energy stored in the rotating parts is no longer sufficient to overcome the compression of the gases in the cylinder. The last compression produced in this way then presses the compressing piston backward a little way so that the combustible mixture is partly compressed in the cylinder in which the combustion would occur if the ignition had not been cut off. The compression in each of the two cylinders in question causes the respective pistons to come to rest near midstroke due to the form of the crank-shaft of an ordinary four-cylinder engine. Thus when the engine is at rest there is always one cylinder whose piston is near the middle of the working stroke, and consequently a spark must be produced in this cylinder to ignite the partly compressed combustible mixture therein to start the engine again. However, during running the ignition occurs in that cylinder having its piston near the outer dead point in the compression stroke. These conditions afford an opportunity for passing from starting ignition to running ignition without requiring a switching operation after the engine has started and with only one set of spark plugs, by maintaining the circuits of starting and running ignition entirely independent of each other and by connecting them alternately to each spark plug in such manner that the starting ignition follows the running ignition with respect to the position of the crank-shaft.

In accordance with the invention, there are two separate current supplies for ignition, two independent circuits connecting the current supplies to a distributer and a spark plug or set of spark plugs connected

to the distributer, whereby the current supplies are alternately connected to each spark plug in such manner that when the piston of the cylinder containing the spark plug in question is in its working stroke only the current supply for starting is in circuit, and when the piston is in the compression stroke only the current supply for running ignition is in circuit with the spark plug. Either supply of current may be a magneto or a battery or one source of current may be used for both supplies provided the circuits are so arranged as to work independently of each other. We prefer however to use a magneto for ignition during running because such ignition has proven itself reliable in the past under various conditions of service. Moreover, either source may be used at any time without the use of separate hand control. When the engine has been started by the starting ignition, the running ignition comes into action immediately after the first combustion without necessitating switching to withdraw one source and introduce the other in passing from starting ignition to running ignition. The main advantage of such a system resides in the availability of both current supplies for ignition at all times, so that the current supply for running ignition automatically comes into action as soon as the engine is in motion, without requiring separate hand operation in passing from one supply to the other.

In the accompanying drawings illustrating several embodiments of our invention, Figures 1 and 1ª show respectively in elevation and in plan, the application of two magneto electric machines to a four-cylinder engine, and Fig. 2 is a diagram of the electrical connections thereof; Fig. 3 shows the electrical connections for a battery for starting ignition and a magneto for running ignition; Fig. 4 shows the electrical connections for two current supplies from a common source to the two ignition systems, one supply for starting ignition and the other for running ignition; Fig. 5 shows the application of the invention to a single cylinder engine; and Fig. 6 shows the same arrangement as in Fig. 2 except that the distributer brushes are fixed while the distributer segments connected to the spark plugs rotate.

A magneto electric machine or a battery, or any other source of ignition current, may be used for starting ignition or for running ignition, or one kind of source may be used for both currents, the only essential condition being that the two currents in any arrangement work independently of each other.

In Figs. 1, 1ª and 2, a is an ignition machine of any well known type for running ignition, shown in this case as a magneto having primary and secondary windings, of which b is the primary winding and d the secondary winding. The interrupter c is operatively connected to the engine, while the brush f pressing on the slip ring e is electrically connected with the brush g of the distributer h. The source for starting ignition is the magneto i with primary winding k, secondary winding m, interrupter l and slip ring n. The brush o for slip ring n is electrically connected with the brush p of the distributer h. The segments q_1, q_2, q_3 and q_4 of the distributer h are electrically connected with respective spark plugs of cylinders 1, 2, 3 and 4, as shown. Now assuming that the engine has been brought to rest by cutting off the ignition, all four pistons will be substantially in the position shown, and cylinders 1 and 2 will contain partly compressed combustible mixture capable of starting the engine upon ignition. When the engine is to be started, the armature of magneto i is rapidly rotated by a hand crank x or any other suitable means. The current produced in the secondary winding m flows by way of slip ring n, brushes o and p, and segment q_1 to the spark plug of the cylinder 1, so that a spark is generated and the partly compressed combustible mixture therein is ignited, whereupon the piston of cylinder 1 is driven downward as indicated by the arrows. In this way the engine is set in motion and as soon as the speed has increased so that magneto a is rotated at sufficiently high speed, an ignition current of sufficient value to generate a spark is produced in cylinder 2 whereupon the rotation of the engine is continued. If the rotation of the engine produced by the starting ignition in cylinder 1 is not sufficiently rapid to produce a spark in cylinder 2 from the magneto a, then the magneto i must be rotated further, continuing the ignitions in those cylinders with which brush p is successively connected, until this condition does occur, whereupon a spark will be produced at that spark plug with which the brush g is at that time connected through the corresponding segment of the distributer. As soon as the engine has fairly started the magneto a produces ignition of the combustible mixture in the several cylinders, while the magneto i is stopped and therefore produces no current. When the engine is at rest, the brush g of the distriubter is connected with that segment which corresponds to the spark plug of the cylinder in the compression stroke, while brush p is connected to the spark plug of the cylinder in the expansion or working stroke in the neighborhood of the outer dead point. From this it will be seen that brush p follows brush g with respect to the direction of rotation of the engine.

It has been pointed out how the engine may be set into motion by means of the starting ignition if mixture capable of

proper combustion is in one cylinder. Now it is possible to start the engine by the starting current without initially having combustible mixture in one of the cylinders, if the starting crank is connected to the engine. In this way the operation of the starting crank first brings the necessary combustible mixture into the cylinder, while the starting source produces ignition of the mixture in that cylinder in which the expansion stroke is occurring. The arrangement may be such that the starting magneto is turned at the same time as the engine by employing a disengageable coupling, or the like, to connect the engine or crank and the starting magneto during the cranking operation; but when the battery is used as the starting source it is only necessary to provide means for switching the starting source into circuit when the starting crank is being operated. Furthermore it is immaterial to the invention whether the starting magneto is driven by hand or by releasing a previously wound spring operatively connected to the magneto or whether the starting crank is operatively connected to the starting magneto by suitable gears or the like. When a spring is used for this purpose, a push button may be used to bring the source of starting current into operation.

The operation of the arrangement shown in Fig. 3 is similar to that already described except that the battery r with an ignition coil s and a mechanically operated interrupter t replaces the magneto i for starting the engine, whereupon starting is accomplished by closing the circuit through a push button, as will be readily understood.

In Fig. 4 the two current supplies are fed from a common source, the battery r, although two separate batteries or other suitable sources may be used for the purpose, the only essential condition being that the secondary winding s forming the current supply for starting ignition be kept separate from the secondary winding s_1 forming the current supply for running ignition.

Fig. 5 shows the invention applied to a single cylinder engine, in which case it is necessary that both current supplies must work independently of each other. For this purpose the member e has two segments so formed that one is connected to the spark plug when the starting magneto is in operation, while the magneto for running ignition produces an ignition current when the other segment is connected to the spark plug of the cylinder. The two segments must be so arranged that they are never connected to the spark plug at the same time, so that the current from one source can never be discharged over the circuit of the other source.

The arrangement shown in Fig. 6 is similar to that described above except that the brushes g and p are stationary while the distributer h having its segments connected to the spark plugs rotates.

Having thus described our invention, what we claim is:

1. In an electric ignition system for internal combustion engines, a cylinder having a piston and a spark plug, a current supply adapted to produce a spark at said plug for starting ignition, an independent current supply adapted to produce a spark at said plug for running ignition, means for electrically connecting the first named supply to said plug when the piston is in the working stroke and means for electrically connecting the second named supply to said plug when the piston is in the compression stroke.

2. In an electric ignition system for internal combustion engines, a cylinder having a piston and a spark plug, a current supply adapted to produce a spark at said plug for starting ignition, an ignition machine adapted to produce a spark at said plug for running ignition, means for electrically connecting the supply for starting ignition to said plug when the piston is in the working stroke, and means for electrically connecting said machine to said plug when the piston is in the compression stroke.

3. In an electric ignition system for internal combustion engines, a cylinder provided with a spark plug, an ignition machine adapted to produce a spark at said plug for starting ignition when the engine is at rest, a second ignition machine operatively connected to the engine and adapted to produce a spark at said plug for running ignition when the engine is rotating at sufficiently high speed, and means for electrically connecting said machines alternately to said plug.

4. In an electric ignition system for internal combustion engines, a cylinder having a piston and a spark plug, an ignition machine adapted to produce a spark at said plug for starting ignition, a second ignition machine adapted to produce a spark at said plug for running ignition, means for electrically connecting the first named machine to said plug when the piston is in the working stroke, and means for electrically connecting the second named machine to said plug when the piston is in the compression stroke.

5. In an electric ignition system for internal combustion engines, a cylinder provided with a spark plug, an ignition machine adapted to produce a spark at said plug, a second ignition machine operatively connected to the engine and adapted to produce a spark at said plug for running ignition when the engine is rotating at suffi-

ciently high speed, means for electrically connecting said machines in succession to said plug, and means disconnected from the engine for operating the first named machine to produce a spark at said plug for starting ignition when the engine is at rest.

6. In an electric ignition system for internal combustion engines, a cylinder provided with a spark plug, a current supply adapted to produce a spark at said plug for starting ignition, a second current supply adapted to produce a spark at said plug for running ignition, a member having a plurality of segments, electrical connections adapted to connect one of said segments at a time to said plug, and separate electrical connections for connecting said current supplies to the separate segments of said member.

7. In an electric ignition system for internal combustion engines, a plurality of cylinders provided with spark plugs, a current supply adapted to produce a spark at said plugs for starting ignition, a second current supply adapted to produce a spark at said plug for running ignition, a distributer electrically connected to said plugs, electrical connections from the first named current supply to one segment of said distributer, and independent electrical connections from the second named current supply to a segment of said distributer in advance of the first named segment in the direction of rotation of the engine.

8. In an electric ignition system for internal combustion engines, a plurality of cylinders provided with spark plugs, a current supply adapted to produce a spark at said plugs for starting ignition, a second current supply adapted to produce a spark at said plugs for running ignition, a distributer electrically connected to said plugs, two angularly displaced brushes operatively connected to the engine to be rotated thereby in contact with said distributer, electrical connections from the second named current supply to the advanced one of said brushes in the direction of rotation of the engine, and independent electrical connections from the first named current supply to the other of said brushes.

9. In an electric ignition system for internal combustion engines, a plurality of cylinders having pistons and spark plugs, an ignition machine adapted to produce a spark at said plugs for starting ignition, a second ignition machine operatively connected to the engine and adapted to produce a spark at said plugs for running ignition when the engine is rotating at sufficiently high speed, a distributer electrically connected to said plugs, two angularly displaced brushes operatively connected to the engine to be rotated thereby in contact with said distributer, electrical connections from the second named current supply to the advanced one of said brushes in the direction of rotation of the engine, independent electrical connections from the first named current supply to the other of said brushes, and means disconnected from the engine for operating the first named machine to produce a spark at one of said plugs when the engine is at rest.

In testimony whereof we affix our signatures, in presence of witnesses.

GOTTLOB HONOLD.
MAX RALL.
PAUL MUMPRECHT.

Witnesses as to Gottlob Honold:
MAX ANSCHUTZ,
REINHOLD ELWERT.
Witnesses as to Max Rall:
DEAN B. MASON,
EUG. SERRE.
Witnesses as to P. Mumprecht:
M. GERBEAULT,
G. ROOSEVELT PHELAN.